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ABSTRACT

This analysis investigates the relationship between the availability of daylight in classroom and performance of elementary and middle school students in three daylit schools designed by Innovative Design for Johnston County Schools in North Carolina. Results show that students attending daylit schools outperformed students attending artificially lighted schools by 5 to 14 percent. The study asserts that recently built, non-daylit schools did not guarantee better performance. The study showed further that performance was significantly and negatively impacted by placing students in temporary, mobile classroom units; e.g., students temporarily placed in mobile classrooms had their average scores on the California Achievement Test drop by 17 percent. (GR)

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Student Performance in Daylit Schools

ED 458 782

ANALYSIS OF THE PERFORMANCE OF STUDENTS IN DAYLIT SCHOOLS

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ABSTRACT

The conclusions of a recent research project on the impacts of full-spectrum light on student performance and health prompted us to investigate the performance of students attending three daylit schools that were designed by our firm. The 1992 "Study into the Effects of Light on Children of Elementary School Age: A Case of Daylight Robbery" was conducted in Alberta, Canada by the Policy and Planning Branch of Alberta Education. Over a two year period, the study compared children attending elementary schools with full-spectrum light versus children attending similar schools with normal lighting conditions.

The most striking conclusions of this study were:

a. the students in full-spectrum light were healthier and attended school 3.2 to 3.8 days more per year;
b. libraries with superior light resulted in significantly lower noise levels;
c. full-spectrum lighting induced more positive moods in students; and
d. because of the additional vitamin D received by the students in full-spectrum light, they had 9 times less dental decay and grew in height an average of 2.1 cm more (over the two year period) than students attending schools with average light.

The following analysis investigates the relationships between elementary and middle school student performance and natural daylighting. The performance of students attending three daylit schools designed by Innovative Design for Johnston County Schools, North Carolina was analyzed and compared to the County school system as a whole and other new schools within the same County. The first daylit school, completed in August of 1990, was the Four Oaks Elementary School. The Clayton Middle School and the Selma Middle School were very similar in design; both were developed around a daylit prototype design and constructed in the spring of 1993.

1. EVALUATION AND COMPARISON OF TESTING PERFORMANCE

To compare the performance of the students, the test results from both the California Achievement Tests (1987/88 - 1991/92) and the End-Of-Grade Tests (1992/93 - 1994/95) were compiled for every school (16 elementary and 8 middle schools) within Johnston County. The test result summaries were provided by the Johnston County School System. From 1987/88 through 1991/92 the average total battery scores of the California Achievement Tests were compared for 3rd, 4th and 5th grade students. First and second grades were not tested. After 1991/92 the average of the reading and math components of the End-Of-Grade Tests are used to compare performance.

The California Achievement Tests were given each year through the 1991/92 school year. The tests were administered in March or April of the school year. After the 1991/92 school year, the evaluation testing was switched to End-Of-Grade Testing and was given in May of each year. Because of the differences in the tests, it has been recommended by both Johnston County Schools and State Department of Public Instruction that we do not compare scores between the two types of tests.

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The analysis consisted of reviewing:

a. improvement in performance within each school from year to year;
b. relative improvement in performance between Innovative Design's three daylit schools and the improvement in the County-wide average for similar grade levels;
c. first year student performance at a fourth daylit school (designed by another firm); and
d. relative improvement in performance of a new, non-daylit middle school constructed in the County during the same time frame.

Because significant differences existed between the student and teacher make-up at each school, the comparisons we have made do not attempt to draw conclusions regarding the average scores between the various schools. To help minimize this problem of false comparisons, the relative improvement within each school is viewed as the more significant comparison. For example, if the CAT score average at one school increases from 60 to 70, this 17% improvement is compared to another school whose grade average may have risen from 50 to 55, or a 10% improvement. But, the average CAT score of 60 versus 50 was not considered important.

All three of Innovative Design's schools incorporated designs which maximized daylighting through the use of south-facing roof monitors and allowed controlled sunlight to enter into all major occupied spaces within the schools. The roof monitors were designed to provide superior lighting (in excess of 70 footcandles) two-thirds of the time during which the spaces were to be utilized. In all cases the roof monitors were equipped with baffles which eliminate glare into the rooms and with light sensors which control the artificial lighting. Smaller windows were also incorporated for view but were not a significant element in the daylighting strategies.

2. FOUR OAKS ELEMENTARY SCHOOL

The Four Oaks School situation is unique because we were able to trace the progression of a rather homogeneous group of students through various classroom environments. In December of 1988 the majority of the old Four Oaks School burned to the ground and the facilities were replaced by a new, daylit school. During the 1988/89 and 1989/90 school years the students were placed in mobile units/temporary facilities. In August of 1990 the new daylit K-5 School was completed and the first CAT's were taken by students in the new daylit school during 1990/91. The last year that CAT's were given was the 1991/92 school year.

From a case study standpoint, the Four Oaks situation reflects a good comparison because we are able to track a student population from 1) a condition where the same group of students was in a typical Johnston County school setting, to 2) a situation where they were relocated to mobile classrooms, to 3) where the students were in daylit school facilities.

Table 1 shows the results of the CAT scores for the students at the Four Oaks School and the averages for all Johnston County School (including the daylit schools) during the same time frame. The scores reflect the averages of the total battery of reading, language, and math.

Four Oaks Elementary Daylit School (1987/88 - 1991/92 California Achievement Tests

Grade	Four Oaks/County	87/88	88/89	89/90	90/91	91/92
3rd	Four Oaks	67	61	67	79	76
	County Average	63	70	68	66	65
4th	Four Oaks	70	55	65	70	72
	County Average	57	58	64	62	65
5th	Four Oaks	52	61	56	66	69
	County Average	56	68	63	67	67
Ave	Four Oaks 3-5	63.0	59.0	62.7	71.7	72.3
	County Average	58.7	65.3	65.0	65.0	65.7
CAT Score relative to norm		+4.3	-6.3	-2.3	+6.7	+6.6
% above/below norm		+7%	-10%	-4%	+10%	+10%

2.1 Four Oaks Conclusions:

Before the school was destroyed by fire in 1988, the students at Four Oaks had CAT's 7% higher than the norm within Johnston County. As students were relocated and placed in mobile classrooms, their performance dropped dramatically. The following year the student's grades went from 7% above to 10% below the norm - a 17% decrease in performance.

The first year the CAT's were given, after the new daylit K-5 school was complete, the students' performance increased, equally dramatically, to 9% above the norm. The next year, the last that the California Achievement Tests were given, the student performance leveled off and was again 9% above the norm for the county.

In comparing the relative increase in performance between the 1988 (the testing year before the fire) and 1992 (the last year of comparable data), the county-wide average scores increased from 58.7 to 65.7, or by 12%. However, the students' performance at Four Oaks, during the same timeframe, increased at a 3% higher rate of 15%, going from 63 to 72.3. Figure 1 shows this comparison.

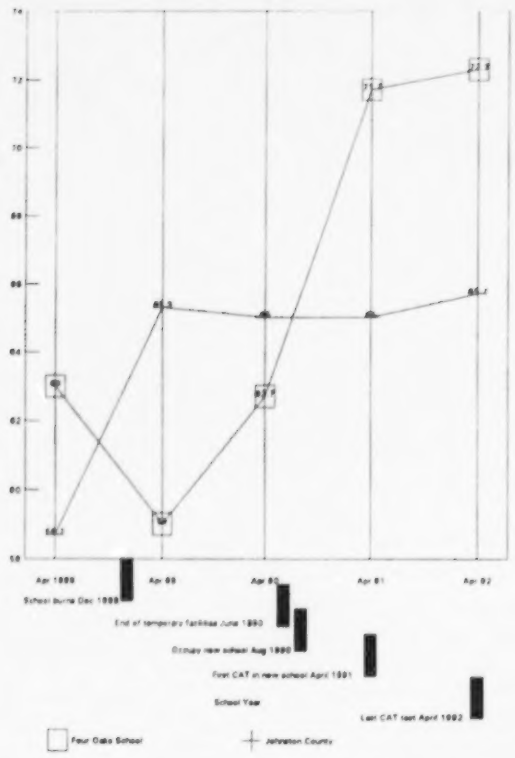

Fig. 1 California Achievement Test Score Four Oaks School vs. Johnston County

3. DAYLIT CLAYTON AND SELMA MIDDLE SCHOOLS

Comparisons were made between the End-Of-Grade Testing results at the new daylit Clayton and Selma Middle Schools to the other new middle school in the county, North Johnston Middle. These same schools were then compared to the County-wide averages (which included the daylit schools).

Because of changing student body make-ups, it is difficult to accurately compare the students that attended other schools, prior to 1992/93, with those that attended the new Clayton or Selma schools. Because the California Achievement Tests were stopped in 1991/92 and the End-Of-Grade Tests were started in 1992/93, it is even more difficult to accurately track the past progression. Because of this, no attempt has been made to make any comparisons between later years and years prior to 1992/93. However, since the Clayton and Selma students were at the new schools for only a couple of months prior to the first year of the End-Of-Grade testing, this was logically established as the base year. It is assumed that because of the very short time period at the new school during the base year, little impact would have occurred.

These 1992/93 scores were then compared to the results of the next two years to see the relative improvement. To help eliminate as many variables from the comparisons as possible, the test results between 1994 and 1995 were averaged. Between 1993 (base year) and the average of 1994 and 1995, the County-wide improvement was 5%. Because testing was not conducted for the Selma 8th grade in 1992/93, the comparisons made for Selma reflect only the 6th and 7th grades.

To better evaluate the impact of multiple years of being in the daylit schools, the scores associated with only the final grade level at each of the schools were also compared (i.e., 8th grade at Clayton and North Johnston and 7th grade at Selma).

End-Of-Grade testing, by law, is given in May of each year. Both Clayton and Selma Middle Schools were opened in March of 1993, just two months prior to the first End-Of-Grade testing.

Clayton and Selma Daylit Middle Schools (1992/93 - 1994/95 End-Of-Grade Testing)

Grade	School/County	1992/93 Reading	1992/93 Math	1993/94 Reading	1993/94 Math	1994/95 Reading	1994/95 Math
6th	Clayton	70.1	70.9	71.1	75.1	66.6	65.5
	Selma	50.5	43.4	52.8	51.2	58.1	51.7
	N Johnston	61.7	46.1	59.7	62.7	71.6	70.1
	County Aver	63.3	59.1	61.7	64.9	65.8	63.8
7th	Clayton	64.9	66.2	72.4	71.2	77.3	75.7
	Selma	50.5	40.6	55.1	48.4	65.5	55.1
	N Johnston	63.9	63.3	58.6	50.8	73.9	67.4
	County Aver	65.2	57.6	59.9	59.5	72.0	68.8
8th	Clayton	67.2	71.1	67.5	68.1	83.6	83.9
	N Johnston	75.5	64.3	61.1	56.7	71.8	65.3
	County Aver	67.4	60.1	67.3	61.3	73.9	66.5

Average of Reading/Math for all Grades

	1992/93 Base Year	Average 1993-95	%Improvement Base-Average
Average Scores			
Clayton 6-8	68.4	73.2	+7%
Selma 6-7	46.3	54.8	+18%
N Johnston 6-8	62.5	64.2	+3%
County Aver 6-8	62.1	65.4	+5%
County Aver 6-7	61.3	64.6	+5%
EOG Score relative to norm			
Clayton	+6.3	+7.8	+1.5
Selma	-15.0	-9.8	+5.2
N Johnston	+.4	-1.2	-1.6

Average of Reading/Math for Last Grade Only

	1992/93	1993/94	1994/95	%Improvement Base-1994/95
Average Scores				
Clayton 8th	69.2	67.8	83.8	+21%
Selma 7th	45.6	51.8	60.3	+32%
N Johnston 8th	69.9	58.9	68.6	-2%
County Aver 8th	63.8	64.3	70.2	+10%
County Aver 7th	61.4	59.7	70.4	+15%

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3.1 Non-Daylit North Johnston Middle School

California Achievement Test data is also available for the non-daylit North Johnston Middle School for the time period of 1987/88 to 1988/89 when the students were in the old North Johnston Middle School, and from 1989/90 to 1991/92 after they moved to the new school. Although test results can't be compared before and after 1992, (because one being the CAT and the other being End of Grade) it is interesting to see if there was a positive trend after the students moved into the new school and to see if this trend followed in subsequent years. North Johnston Middle School was opened in August of 1989.

It would be logical to assume that any new school would have a positive impact. This didn't prove to be the case.

Non-Daylit North Johnston Middle School (1987/88 - 1991/92 California Achievement Tests)

		Old North Johnston		New North Johnston		
Grade	N Johnston/County	87/88	88/89	89/90	90/91	91/92
6th	North Johnston	52	53	59	56	49
	County Average	54	56	63	65	65
7th	North Johnston	58	54	54	57	61
	County Average	53	53	55	58	60
8th	North Johnston	59	55	61	52	53
	County Average	56	55	56	54	53
Aver	North Johnston	56.3	54.0	58.0	55.0	54.3
	County Average	54.3	54.7	58.0	59.0	59.3
CAT Score relative to norm		+2.0	-.7	0.0	-4.0	-5.0
% above/below norm		+4%	-1%	0%	-7%	-8%

3.2 Clayton, Selma, and North Middle Conclusions:

The fact that a school is new doesn't guarantee that grades improve. Between 1988 and 1992, the average CAT results in Johnston County (for the same 6-8 grade levels) increased 9%. To the contrary, the new North Johnston Middle School (non-daylit) experienced a 4% decrease in test results. This comparison seems reasonable since there was a very high correlation between the students that attended the old North Middle and those that attended the new North Middle. However, if you look at just the progress from the first year in the new school (1989/90) to 1991/92 the results are similar. The County-wide average improved 2% while North Johnston decreased in performance by 6% - a net 8% drop in student performance.

In tracking North Johnston Middle even further, when the End-Of-Grade Testing started in 1993, one sees no improvement as the school closely tracks the County-wide averages.

The daylit schools performed much better. In comparing the scores in 1992/93 (two months after opening operations for both Clayton and Selma) with the average scores between 1993/94 and 1994/95, the improvement is significant. While the County-wide improvement in test results improved 5%, Clayton improved 7% and Selma rose by 18%. North Johnston's students tracked the County-wide 5% improvement.

However, if you compare only the older students, reflecting those who attended the daylit school for three years (two for Selma) from 1992/93 to 1994/95, one sees even more notable improvement. This analysis attempts to determine the impact of multiple years in a daylit school. For example, in 1992/92, the Clayton eighth graders were in the daylit school for only a couple of months. At the time of the 1993/94 testing, the eighth graders had been there two years and by 1994/95 - three years. At the daylit Clayton Middle, the 8th graders improved by 21% from the base year, while the other 8th graders in the County improved by 10%. At North Johnston Middle the students' performance actually decreased by 2%. Selma Middle, the other daylit school, showed even greater improvement with test results rising by 32% (versus norm of 15%) over those in 1992. This would indicate the longer-term impact by attending a daylit school could result in a 14% (11% + 17% / 2) increase in student performance.

4. DAYLIT CLEVELAND ELEMENTARY SCHOOL

Although the school is too new to have any long term data, it is important to note that the daylit Cleveland Elementary School has also shown a positive benefit over the norm in Johnston County. During the first year (started in August of 1994) in operation, the students at the new daylit school performed 1% above the norm.

Daylit Cleveland Elementary School (1994/95 End-Of-Grade Testing)

Grade	Cleveland /County	1994/95
3rd	Cleveland	63.2
	County Average	66.7
4th	Cleveland	79.9
	County Average	70.7
5th	Cleveland	68.1
	County Average	71.8
Aver.	Cleveland	70.4
	County Average	69.7
EOG Score relative to norm		+.7
% above/below norm		+1%

5. SUMMARY OF CONCLUSIONS

Although there are many variables that can alter student performance, it appears that the students attending daylit schools clearly benefit by being in the superior, daylit learning environments. The following summarizes our conclusions:

1) The students who attended daylit schools out-performed the students who were attending non-daylit schools by **5 to 14 percent**, depending upon whether you consider short or long-term impacts. When analyzing the improvement experienced by all the reference classes at Four Oaks, Clayton, and Selma, the average improvement was **4.7%**.

School	Comparison Yrs	Net Change in Student Performance	Percent Improvement
Four Oaks K-5	87/88 - 91/92	+4.3 above norm to +6.6 = +2.3	107% above norm to 110% = +3%
Clayton	92/93 - 93/95	+6.3 above norm to +7.8 = +1.5	110% above norm to 112% = +2%
Selma	92/93 - 93/95	-15.0 below norm to -9.8 = +5.2	24% below norm to 15% = +9%
		Average CAT Grade = +3.0	Ave. % Improvement = **+4.7%**

When you consider the impact on student performance resulting from being within a daylit facility for multiple years, the impact is even greater. During the same timeframe, Clayton's 8th graders showed a 21% improvement versus the norm improvement of 10%. The Selma Middle School 7th graders showed a 32% gain versus the norm of 15%. This equates to an average increase of **14% better performance** by the students in daylit schools.

2) "New" does not necessarily translate into better performance. The new, non-daylit North Johnston Middle School actually showed a negative impact on the students' performance.

3) It is quite clear that placing students in temporary, mobile classroom units had a very significant and negative impact on the performance of students. The year following the Four Oaks School destruction and the subsequent students relocation, the average CAT scores went from 7% above the norm to 10% below the norm for the County - a 17% decrease in student performance.

6. REFERENCES

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